Docket No.: 0649-0902P
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Nobuo SUZUKI et al.

Application No.: 10/620,459 | Confirmation No.: 9186

Filed: July 17, 2003 | Art Unit: 2622

For: SOLID-STATE IMAGE PICK-UP DEVICE | Examiner: C. S. Yoder

DECLARATION UNDER 37 CFR 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

I, Mr. Nobuo SUZUKI, do hereby state and declare as follows:

1. I am a co-inventor of the invention disclosed and claimed in the above-identified U.S. patent application.

2. In March of 1973, I graduated from Tokyo University, Faculty of Engineering with a Ph.D. in electronic engineering.

3. In April of 1999, I joined Fuji Photo Film Micro Device Co., Ltd. and engaged in research in the field of CCD solid-state image pick-up devices.

4. I retired from Fuji Photo Film Micro Device Co., Ltd. on November 9, 2004.

5. I have reviewed the Office Action dated January 30, 2008, issued in the above application.

6. I am the author of the Invention Disclosure Document dated March 11, 2002, which forms the basis for the subject matter disclosed in the instant application, and which is attached hereto along with a full English translation.

7. As evinced by the Invention Disclosure Document, I consider Figure 3 of the instant application to be part of the novel concepts of the present invention. Figure 3 of the application is comparable to Figure 2(a) of the Invention Disclosure Document. Section (3) of the Invention Disclosure Document describes the concepts considered to be the Conventional Art and the drawbacks therein. Sections (4) and (5) describe the Problem to be Solved by the Invention and the Means for Solving the Problem, respectively. Section (6a) describes the first example of a solid-state image pick-up device considered to be a means for solving the problem of the conventional art, and which is part of the novel features of the present invention. Within section (6a) is the description of Figure 2(a), including the following:

> "[I]n the conventional example, the percentage of wiring portions between pixels is large. To the contrary, in this example, since the low sensitivity pixels are disposed in a middle of the pitch value of the high sensitivity pixels, this wiring portion is not provided."
>
> [Page 5, lines 10-12; emphasis added]

8. From the Invention Disclosure Document, it is clear that I do not consider Figure 3 of the instant specification be represent either a conventional solid-state image pick-up device or statutory prior art under 35 U.S.C. § 102(e), nor have I admitted as such.

9. It is declared by undersigned that all statements made herein of undersigned's own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statement

and the like so made are punishable by fine or imprisonment, or both, under 18 U.S. Code 1001 and that such willful false statements may jeopardize the validity of this application or any patent issuing thereon.

Dated: 4/16/2008 Signed: Nobuo Suzuki
Nobuo SUZUKI

Invention Report/ Assignment (Table A)

Reference No.
P01069

Inventor	Supervisor	Evaluator	Chief of dep.	→	D receipt	D chief	Office expenses
Seal	Seal	Seal	Seal		Seal	Seal	Eiko P.O. b

Internal inventors

Title of the invention		Solid-state image pick-up device			
Assignment of rights to file applications and consent		I hereby assign rights to obtain patents in connection with this invention in Japan and foreign countries to FUJIFILM Microdevices Co., Ltd. In addition, I hereby consent that the co-inventor assigns his share in connection with this invention to his employer and so on.			
Internal inventors	Order of inventors	Employee No.	Name	Contribution rate (%)	Seal
	1	98118	Nobuo SUZUKI	50	
	2	71329	Kazuyuki MASAKANE	50	

Number of inventors			Joint applicants (other than FF)	Contract	
Internal	External	Total	(1.) Not exist	1. Exist	* If internal inventors are six or more, use additional copy of this form.
2	0	2	2. Exist (Name of joint applicants:)	(2.) Not exist	

Inventors (outside FFM)

Number of applicants (including FFM)		Company	Company filing applications		
Corporate or individual name		Necessity of applicant	Order	Postal code	Address
	FUJIFILM Microdevices	1. Necessary 2. Unnecessary		981-3408	1-6 Matsusaka-daira, Taiwa-cho, Kurokawa-gun, Miyagi-ken
1	FUJIFILM	1. Necessary 2. Unnecessary			
2		1. Necessary 2. Unnecessary			

* In case of "Unnecessary" in necessity of applicant, order and the followings need not be filled in.

Qualification as representative		Name of representative	Share	Cost to be shared	Cost to be covered
1	President & Representative Director	Komori Shigetaka	%	%	1. All costs 2. Filing cost
2			%	%	1. All costs 2. Filing cost

External inventors	Corporate name	Order of inventors	Name	Contribution rate	Seal

* Order of inventors and contribution rate shall apply to all inventors (whether internal or external).

Assignment of rights to file applications and consent	I hereby assign rights to obtain patents in connection with this invention in Japan and foreign countries to you (FUJIFILM Microdevices Co., Ltd.) and I hereby consent that the co-inventor assigns his share in connection with this invention to his employer and so on.

Invention Investigation (Table B)

Reference No.
P01069

Inventor	Supervisor	Evaluator	Chief of dep.
Seal	Seal	Seal	Seal

→

D receipt	D chief
Seal	Seal

Office expenses
Eiko P.O. b

Prior art/similar technology (enter publicly known examples)

Search for publicly known examples	1. Has been conducted 2. Is being continued (3.) Has not been conducted
Publicly known reference	(1)
	(2)
	(3)
	(4)

Gist of this invention

An image having a wide dynamic range can be generated from two simultaneous images (high sensitivity and low sensitivity) by providing high sensitivity pixels and low sensitivity pixels in the Bayer array on lattice points of honeycomb. Furthermore, sensitivities and saturation outputs decrease very little because pixels are provided on the lattice points of the honeycomb.

Evaluation of this invention: Evaluate this invention by selecting one row from among (A), (B) or (C) according to a type of the invention (☑ by inventor, ○ by evaluator)

Type of invention / Evaluation points	(A) Invention relating to improvement of current products/technology	(B) Invention relating to next-generation products/technology	(C) Invention relating to future (5-10 years later) products
(1) Company's working plan (Enter product name if products to be worked are decided)	None/Unknown 2 · Under consideration 4 · 6 · 8 · Decided 10	None/Unknown 1 · 2 · Exist 3 · (4) · Decided 5	→Product name: ( )
(2) Likelihood of avoiding other companies (Evaluate invention by considering other companies' likelihood of working/alternative technology)	Easy 1 · 2 · Feasible 3 · 4 · Difficult 5	Easy 1 · 2 · Feasible 3 · (4) · Difficult 5	
(3) Priority of technology (Evaluate technical/economic effects compared with prior art)	Equal 1 · 2 · High 3 · 4 · Tremendous 5	Equal 1 · 2 · (3) · 4 · Tremendous 5	Equal 1 · 2 · High 3 · 4 · Basic 5
(4) Creativity (Evaluate creativity of issue/idea to be dissolved)		Commonplace 1 · 2 · (3) · 4 · Innovative 5	Commonplace 1 · 2 · Good 3 · 4 · Innovative 5
(5) Technical feasibility (Evaluate invention based on future technology as well)			Unknown 1 · 2 · Feasible 3 · 4 · Already confirmed 5
(6) Relation with development theme (Enter name of development subject if invention relates to development subject)	Exist/Not exist → Name of subject: ( )	Exist/Not exist ✓ → Name of subject: ( )	None 1 · 2 · Undecided 3 · 4 · Exist 5 Name of subject:
Total points	Inventor: 14 points, evaluator: 14 points		

Comprehensive evaluation of invention	Enter evaluator's comments (supplementary comments on evaluation points)
(1.) A rank (Basic invention or invention essential for business strategy) 2. B rank (Invention the Company or other companies are highly likely to use) 3. C rank (Defensive invention to prevent other companies from obtaining rights) 4. D rank (Application to be put off/publication is unnecessary)	Promising as future invention (Yamada).

Degree of urgency as to Japanese application	Necessity of request for examination	Necessity of foreign application
(1.) Ordinary (File within four months from D's receipt) 2. Urgent (File within three months from D's receipt)	1. Request (within one year) ✓ 2. Undecided 3. Unnecessary	(1.) File without fail (Country: USA) 2. File if possible (Country:) 3. Unnecessary

Items to be filled in by D

Rank	Total points	Domestic application	Foreign application	Request for examination	Comments to be filled in by D
B	14	(1.) Sole 2. Consolidation 3. Division 4. Internal priority	1. Necessary (Country: US) 2. Unnecessary	1. Necessary (2.) Unknown 3. Unnecessary	

INVENTION DISCLOSURE DOCUMENT

To General Manager of Development Department

March 11, 2002

K Dept. Nobuo SUZUKI

(1) Title of the Invention

Solid-state image pick-up device

(2) Technical Field of the Invention

The invention relates to a solid-state image pick-up device, and particularly to a color CCD image sensor having a wide dynamic range.

(3) Conventional Art and Its Drawback

A conventional example of a single-plate color solid-state image pick-up device is shown in Fig. 1. Fig. 1 is a configuration diagram of the single-plate color solid-state image pick-up device. The conventional example of Fig. 1 is a CCD area image sensor of a progressive scanning type that can transfer signal charges of a two-dimensional pixel array to vertical CCD registers at a time and read out the signal charges. Although number of the pixels is a few hundreds of thousands to a few million, such a portion is omitted in Fig. 1. The two-dimensional pixel array, three-phase drive CCD registers (three-layer polysilicon electrode structure), a two-phase drive horizontal CCD register and an output section are provided. A color filter array is a color filter array of the Bayer system that is used in a single-plate color solid-state image pick-up device having a general pixel array.

(Supplemental Description of Fig. 1)

11: pixel (photo diode) 12 vertical CCD register

13: position of a reading gate used to read out a signal charge from a pixel to a transfer electrode of the vertical CCD register

14-16: transfer electrodes 17-19: transfer electrodes

30: horizontal CCD register 31: output section

32: output

33, 34, 40-42: electrode terminals 11g: pixel having a green color filter

p.s. Please acknowledge your safe receipt of this letter by return facsimile.

11b: pixel having a blue color filter

11r: pixel having a red color filter

In digital still cameras using the conventional example, scenery viewed through a window from a room may be shot as a stark white image. In order to avoid this, an image of a wide dynamic range is generated from two images (high sensitivity and low sensitivity) that are consecutively shot at a short interval of time.

Drawback of the Conventional Example: Since times of the two images to be combined are not the same, if a moving object is shot, the resultant image becomes unnatural.

Difference between the Invention and the Conventional Example: Differences therebetween are in that a solid-state image pick-up device has low sensitivity pixels and high sensitivity pixels and furthermore, the low sensitivity pixels (small pixels) are provided in positions shifted by 1/2 of a pitch from the high sensitivity pixels in both of the vertical and horizontal directions.

(4) Problem to be Solved by the Invention

To realize a solid-state image pick-up device that can shoot a moving object naturally and can obtain an image of a wide dynamic range.

(5) Means for Solving the Problem

By providing the low sensitivity pixels and the high sensitivity pixels, simultaneity between the high sensitivity pixels and the low sensitivity pixels is ensured. Furthermore, by providing the small low sensitivity pixels in the positions shifted by 1/2 of the pitch from the high sensitivity pixels in both of the vertical and horizontal directions, deterioration of image quality (due to decrease in sensitivity and decrease in saturation output) is avoided thereby solving the problem.

(6a) Example

A first example of the solid-state image pick-up device is shown in Fig. 2. Fig. 2(a) is the overall configuration view, and Figs. 2(b) and 2(c) show explanatory views of a micro lens. To obtain an image of a wide dynamic range, it is preferable to set a sensitivity of the low sensitivity pixel to about 1/4 to about 1/128 of that of the high

sensitivity pixel. In that case, it is preferable to set a saturation signal charge amount of the low sensitivity pixel to about 1 to about 1/64 of that of the high sensitivity pixel. It is necessary that the low sensitivity pixel does not saturate up to a certain light amount (for example, about 4 times to about 16 times as large as the saturation light amount of the high sensitivity pixel) even if the high sensitivity pixel saturates. An area of a plan view of the micro lens shown in Fig. 2(b) is in proportional to the sensitivity. Accordingly, if, for example, a sensitivity ratio is 1/16, the sensitivity of the high sensitivity pixel decreases about 6%, and the sensitivity decreases very little. Also, the saturation charge amount is in proportional to an area of the photo diode. Accordingly, if the sensitivity ratio is set to 1/16 and four times saturation is selected, the area of the photo diode of the low sensitivity pixel becomes 1/4 of that of the photo diode of the high sensitivity pixel. Increase in area of the photo diode of the low sensitivity pixel is not small. However, in the conventional example, the percentage of wiring portions between pixels is large. To the contrary, in this example, since the low sensitivity pixels are disposed in a middle of the pitch value of the high sensitivity pixels, this wiring portion is not provided. Therefore, considering this area reduction, increase in area of photo diodes for newly providing the low sensitivity pixels is quite small. That is, in this example, even if the low sensitivity pixel array is added in comparison with the conventional example, the high sensitivity pixels decrease very little in sensitivity and in saturation charge amount. Thereby, conventional performance can be maintained.

It is noted that in this example, a single reading-out operation of the horizontal CCD register reads out one row of the high sensitivity pixels and one row of the low sensitivity pixels.

Detailed description is omitted (will be orally explained).

(Supplemental Description of Fig. 2(a))

110: low sensitivity pixel (photo diode)

111: high sensitivity pixel (photo diode)

112: four-phase drive vertical CCD register (two-layer polysilicon electrode structure)

113: position of a reading gate used to read out a signal charge from a pixel to a transfer electrode of the vertical CCD register

114-117: transfer electrodes 118, 119: transfer electrodes

130: horizontal CCD register 131: output section

132: output

133, 134, 140-143: electrode terminals

110g: low sensitivity pixel having a green color filter

110b: low sensitivity pixel having a blue color filter

110r: low sensitivity pixel having a red color filter

111g: high sensitivity pixel having a green color filter

111b: high sensitivity pixel having a blue color filter

111r: high sensitivity pixel having a red color filter

(6b) Other examples

A second example is shown in Fig. 3. In the first example of the solid-state image pick-up device, the vertical CCD register is a four-phase drive CCD and reads out high sensitivity pixels and low sensitivity pixels at the same time, but in the second example, the vertical CCD register is an eight-phase drive CCD and reads out high sensitivity pixels and low sensitivity pixels two times separately. Since high sensitivity pixels and low sensitivity pixels are read out by two reading-out operations, an area of the vertical CCD register can be reduced. Accordingly, an area of pixels increases and saturation output increases, which is the advantageous. A single reading-out operation of the horizontal CCD register reads out two rows of the high sensitivity pixels or two rows of the low sensitivity pixels.

Description is omitted (will be orally explained).

(Supplemental description of Fig. 3)

210: Low sensitivity pixel (photo diode)

211: High sensitivity pixel (photo diode)

212: Vertical CCD register

213: Position of a reading gate used to read out a signal charge from a pixel to a transfer electrode of the vertical CCD register

214-221: Transfer electrodes

222, 223: Transfer electrodes

230: Horizontal CCD register

231: Output section

232: Output

233, 234, 240-247: Electrode terminals

210g: Low sensitivity pixel having a green color filter

210b: Low sensitivity pixel having a blue color filter

210r: Low sensitivity pixel having a red color filter

211g: High sensitivity pixel having a green color filter

211b: High sensitivity pixel having a blue color filter

211r: High sensitivity pixel having a red color filter

In an example in Fig. 3, if a four-phase drive CCD is configured by combining electrodes of the first phase and second phase, combining those of the third phase and fourth phase, combining those of the fifth phase and sixth phase, combining those of the seventh phase and eighth phase of the vertical CCD register, the same effect can be obtained..

A third example is shown in Fig. 4. The number of the vertical CCD register is 1/2 compared with the first example. This, like the second example, reads out high sensitivity pixels and low sensitivity pixels by two reading-out operations. Since high sensitivity pixels and low sensitivity pixels are read out by two reading-out operations, an area of the vertical CCD register can be reduced. Accordingly, an area of pixels increases and saturation output increases, which is advantageous. A single reading-out operation of the horizontal CCD register reads out one row of the high sensitivity pixels or one row of the low sensitivity pixels.

Description is omitted (will be orally explained).

(Supplemental description of Fig. 4)

310: Low sensitivity pixel (photo diode)

311: High sensitivity pixel (photo diode)

312: Vertical CCD register

313: Position of a reading gate used to read out a signal charge from a pixel to a transfer electrode of the vertical CCD register

314-317: Transfer electrodes

318, 319: Transfer electrodes

330: Horizontal CCD register

331: Output section

332: Output

333, 334, 340-343: Electrode terminals

310g: Low sensitivity pixel having a green color filter

310b: Low sensitivity pixel having a blue color filter

310r: Low sensitivity pixel having a red color filter

311g: High sensitivity pixel having a green color filter

311b: High sensitivity pixel having a blue color filter

311r: High sensitivity pixel having a red color filter

A fourth example is shown in Fig. 5. While the purpose of the first to third examples is to obtain a combined image having a wide dynamic range, that of the fourth example is to obtain a high resolution image. For that purpose, a color filter of low sensitivity pixels is only white. Structures except for a color filter of low sensitivity pixels are the same as those of the first to third examples. Fig. 5 shows a color filter only. White means pixels not having a color filter or pixels having a transparent color filter.

A high resolution image can be obtained by producing luminance signals from high sensitivity pixel signals and while pixel signals after detecting partial characteristics of an image (correlative direction, etc.) in white pixel signals and high sensitivity pixel signals. A color filter of low sensitivity may not only be white but also green, yellow, cyan and so on.

This can be worked in various forms, as follows.

1) Not only a color filter array of the primary color Bayer but also a checked-complementary color filter array of cyan, green, yellow and magenta or a striped filter may do (Fig. 6 shows an example of a complementary color filter).

2) The above explanation is given premised on that high sensitivity pixels and low sensitivity pixels are always read out. However, if an image having a wide dynamic range or a high solution image is not necessary, only high sensitivity pixels are read out and low sensitivity pixels do not need to be read out. An ordinary image can be obtained simply by signal processing output signals of high sensitivity pixels.

3) As to a shape of the micro lens, the high sensitivity pixel does not have to be octagonal and the low sensitivity pixel does not have to be tetragonal in the plain view as in the Fig. 2(b), but have only to be a polygon having four angles or more.

4) It is possible to make a three-plate color camera having a wide dynamic range by using a black-and-white solid-state image pick-up device with the micro lens as it is but without all color filters (the first to third examples).

(7a) Effect of the invention

Compared with a conventional example, a high sensitivity image and low sensitivity image are simultaneous and a natural combined image can be obtained from a moving subject. Furthermore, by providing the small low sensitivity pixels in the positions shifted by 1/2 of the pitch from the high sensitivity pixels in both of the vertical and horizontal directions, deterioration of image quality due to decrease in sensitivity and decrease in saturation output hardly happens.

In addition, a high resolution image can be obtained by means of signal processing of the low sensitivity pixels as a white filter (actually no color filter).

(8a) Scope of claims

1) A solid-state image pick-up device comprising:

a light receiving section having a high sensitivity pixel array which is arranged in a square shape of a row direction and a column direction perpendicular thereto and having a low sensitivity pixel array which is provided in positions shifted by 1/2 of a pitch from the high sensitivity pixel array in the row direction and in the column direction;

a vertical CCD register group which reads out signal charges optically generated in each pixel of the light

receiving section and which transfers in the column direction;

a horizontal CCD register which receives signal charges transferred from the vertical CCD register group and which transfers the signal charges in the row direction;

an output section which outputs the signal charges transferred from the horizontal CCD register.

2) The solid-state image pick-up device according to claim 1, characterized in that the vertical CCD register group can read out all the signal charges of the photosensitive part at the same time.

3) The solid-state image pick-up device according to claim 1, characterized in that the vertical CCD register group can read out signal charges of high sensitivity pixels and low sensitivity pixels of the light receiving section by two reading-out operations.

4) The solid-state image pick-up device according to claims 1 to 3, characterized in that color filters of red and green or green and blue are alternately arranged in odd rows of the high sensitivity pixel array and low sensitivity pixel array, and that color filters of green and blue or red and green are alternately arranged in even rows of the high sensitivity pixel array and low sensitivity pixel array.

5) The solid-state image pick-up device according to claims 1 to 3, characterized in that color filters of magenta and green or cyan and yellow are alternately arranged in odd rows of the high sensitivity pixel array and low sensitivity pixel array and that color filters of cyan and yellow or magenta and green are alternately arranged in even rows of the high sensitivity pixel array and low sensitivity pixel array.

6) The solid-state image pick-up device according to claims 1 to 3, characterized in that color filters of red and green or green and blue are alternately arranged in odd rows of the high sensitivity pixel array, that color filters of green and blue or red and green are alternately arranged in even rows of the high sensitivity pixel array, and that color filters of white (no color filter) or green, yellow or cyan are provided in the low sensitivity pixel array.

7) The solid-state image pick-up device according to claims 1 to 3, characterized in that color filters of magenta and green or cyan and yellow are alternately arranged in odd rows of the high sensitivity pixel array, that color filters of cyan and yellow or magenta and green are alternately arranged in even rows of the high sensitivity pixel array, and that color filters of white (no color filter) or green, yellow or cyan are arranged in the low sensitivity pixel array.

(9) Brief Description of the Drawings

Described as above, and thus omitted here.

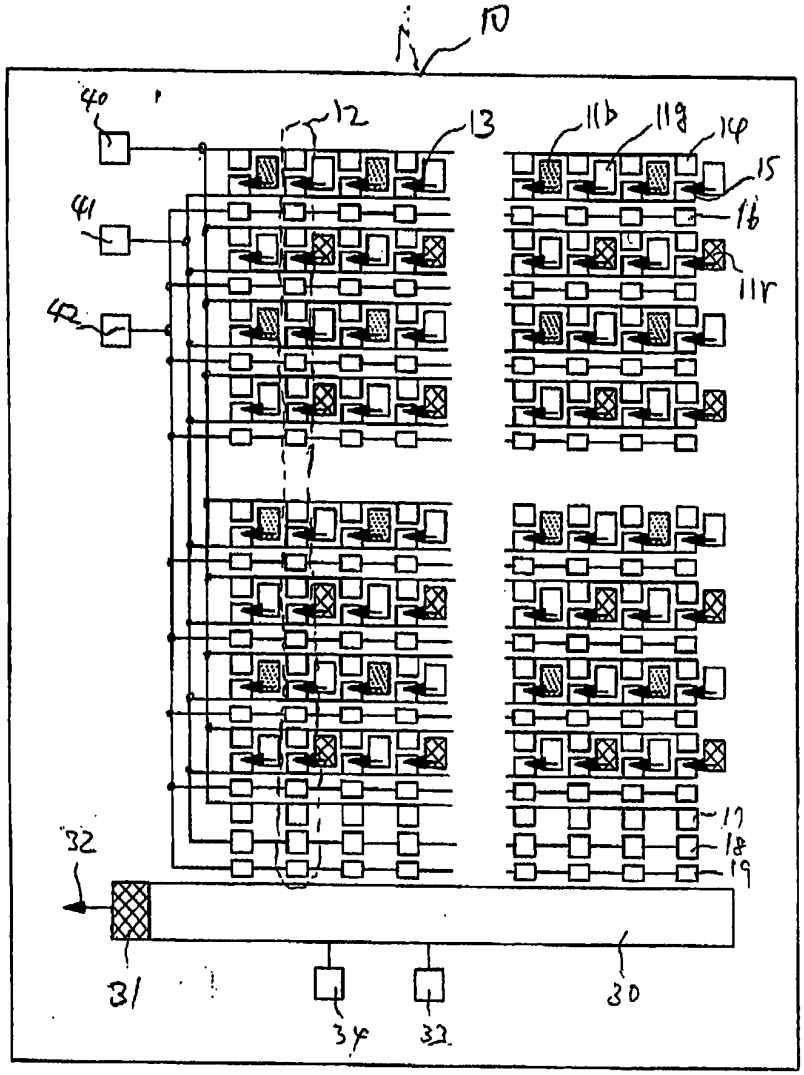

10
40
41
42
12
13
11b
11g
14
15
16
11r
17
18
19
32
31
34
33
30

FIG. 1

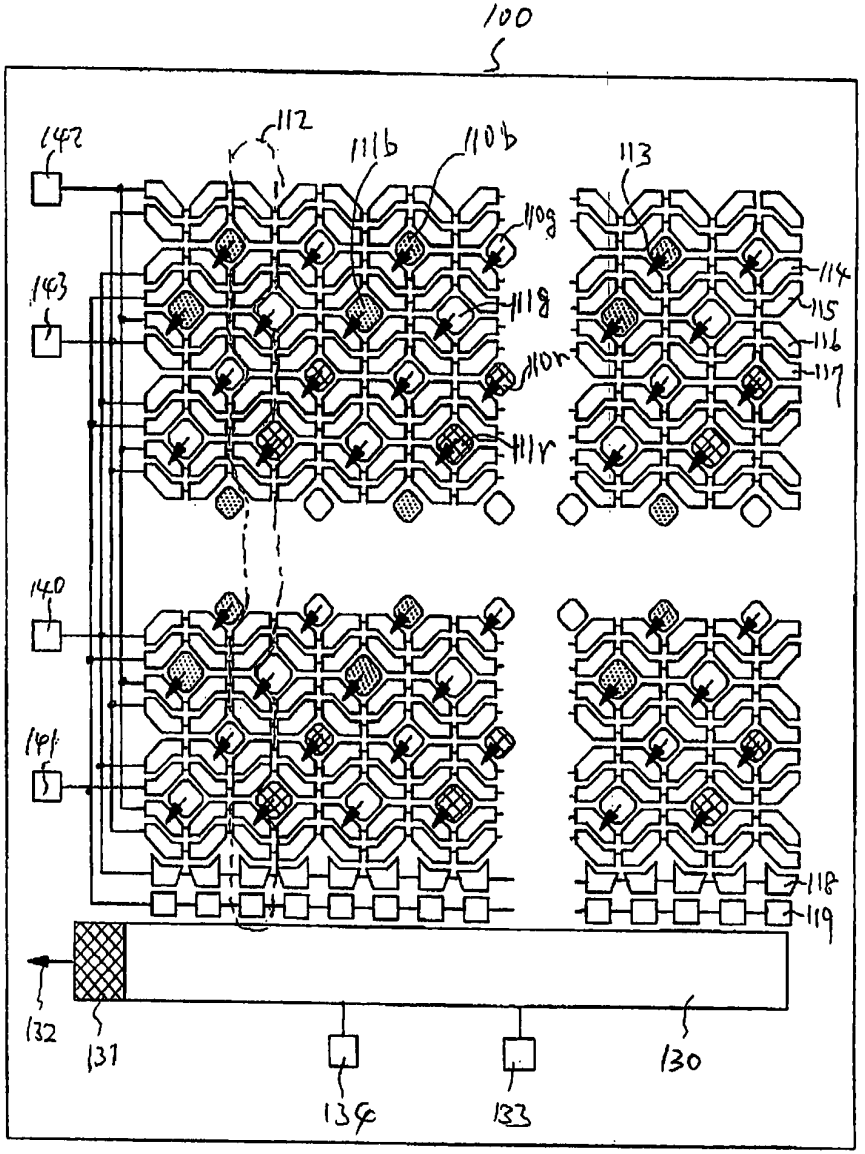
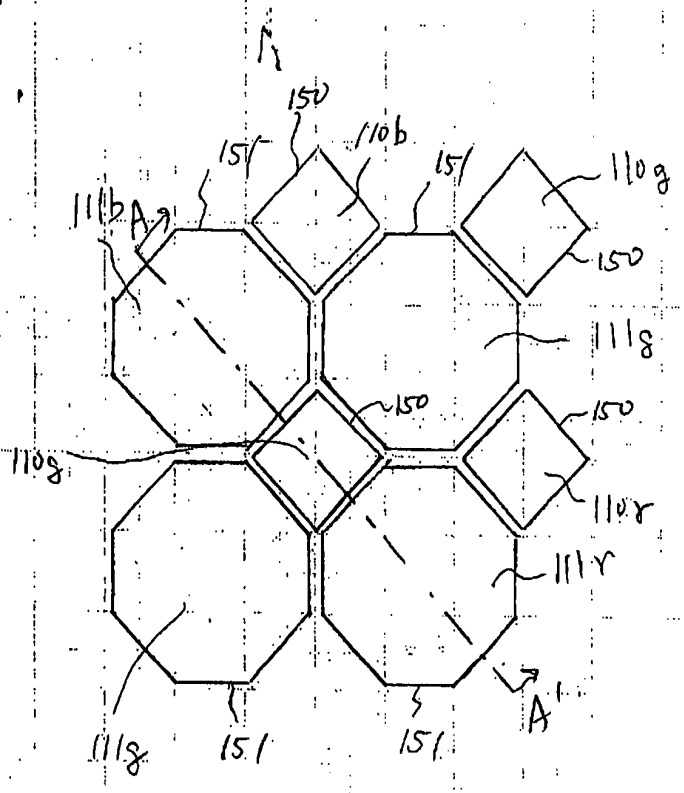
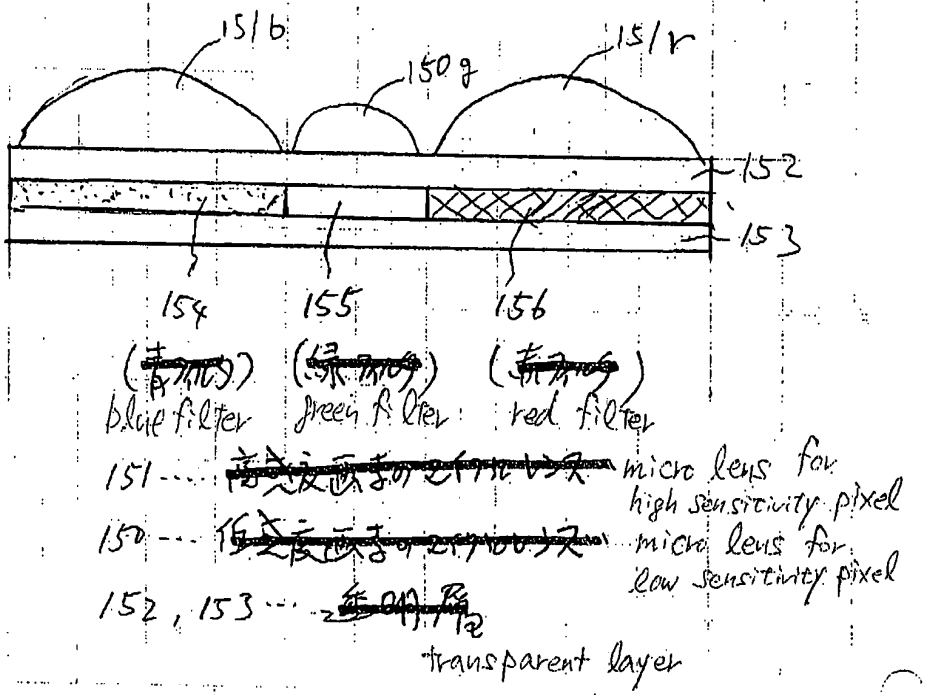

100
142
112
111b
110b
113
110g
114
143
111g
115
110r
116
117
111r
140
141
118
119
132
131
134
133
130

FIG. 2(a)



~~図2(b)~~

FIG. 2(b)



~~図2(c)~~

FIG. 2(c)

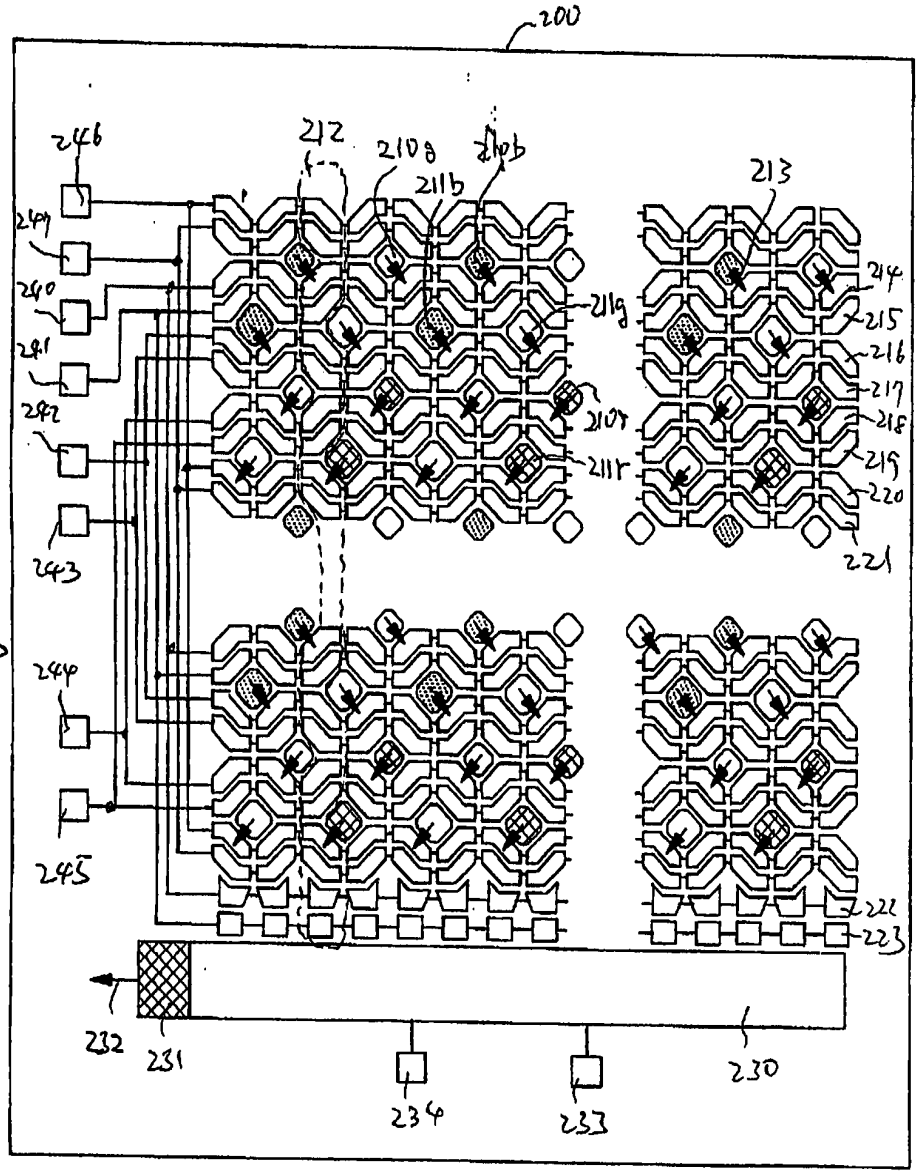

200
212
210a
210b
211b
213
214
215
216
217
218
219
220
221
222
223
211g
210r
211r
241
242
243
244
245
232
231
234
233
230

FIG. 3

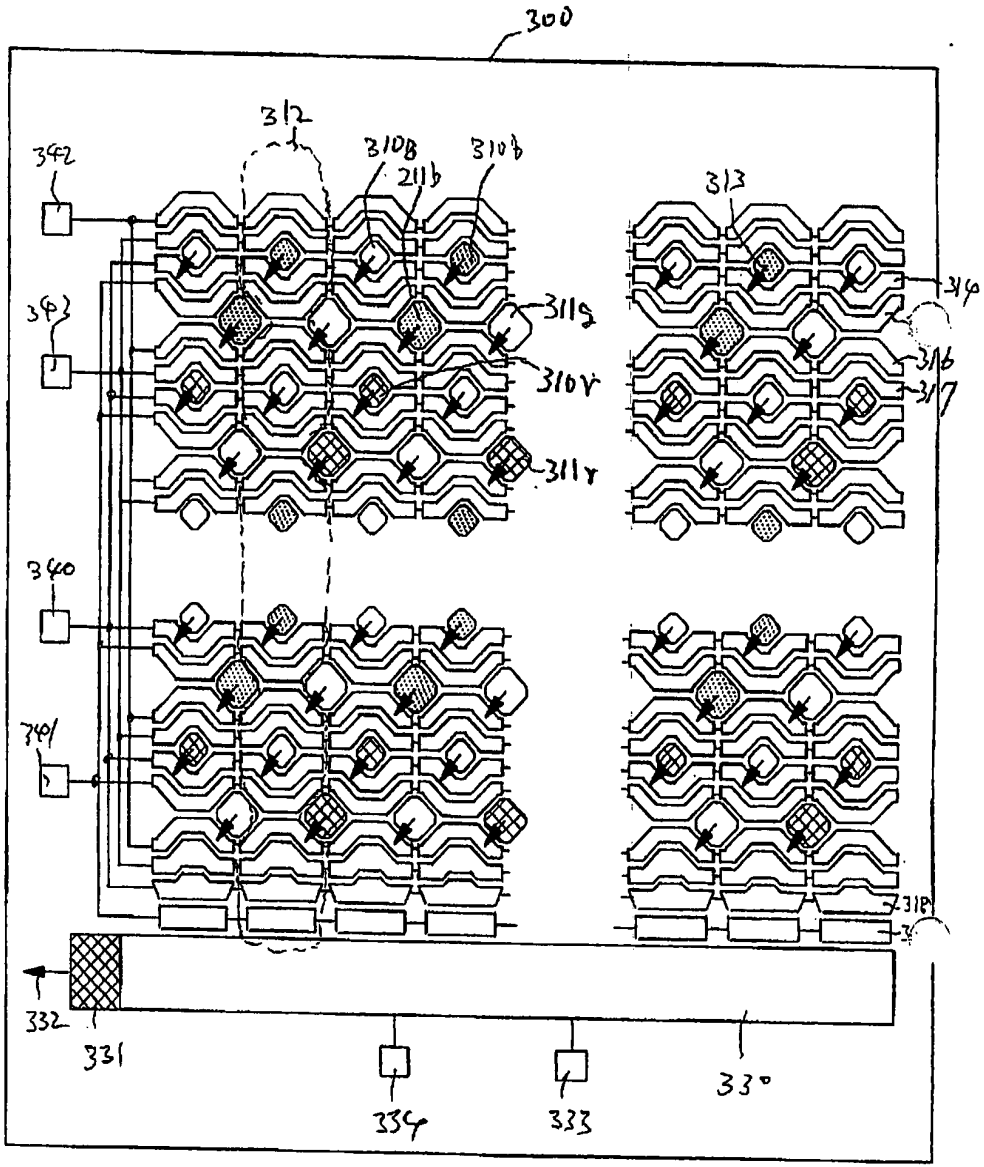
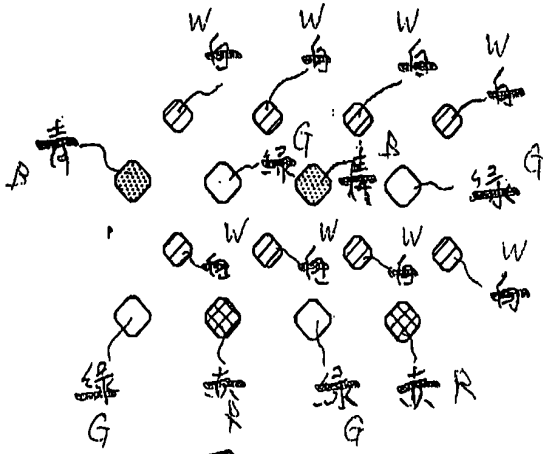
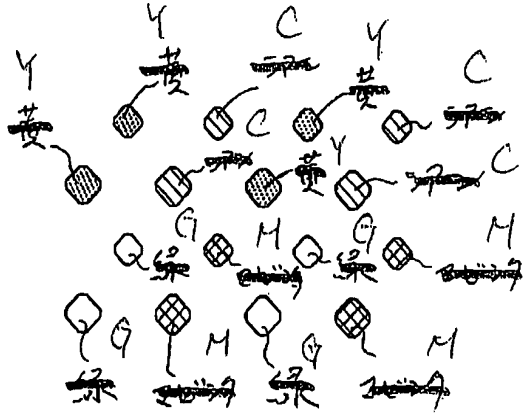

300
312
310a
310b
211b
313
314
316
317
311g
310r
311r
342
343
340
341
332
331
334
333
330
318

FIG. 4



W white
G: green
B - blue
R: red

FIG. 5



G green
Y: yellow
M magenta
C: cyan

FIG. 6

発明調査書（B表）

整理番号
P01069

発明者	上長	評価担当	部門長	D受付	D長	特許事務所
K(部) 14.3.11 鈴木(信)	14.3.12	CD長 14.3.11 山田(哲)	K長 14.3.11	D 14.3.12	D長 14.3.12 栗石	栄 b

従来技術・類似技術（公知例を記入）

公知例調査　1.実施した　2.実施中　③実施していない

公知文献
①
②
③
④

本発明の要旨

ベイヤー配列の高感度画素と低感度画素で、ハニカムの格子点に設けることにより同時性がある2枚の画像（高感度と低感度）から広いダイナミックレンジをもつ画像合成が出来る。さらにハニカム格子点に画素を設けたため、感度や飽和も均一かつ多くとれる。

本発明の評価	発明の類型により(A)、(B)、(C)のうち一列を選択して評価（発明者レ印、評価担当○印）		
評価項目 ＼ 発明の類型	(A)現行製品、技術の改良に関する発明	(B)次世代製品、技術に関する発明	(C)将来(5～10年先)の製品に関する発明
①自社実施予定（実施製品が決まっている場合は製品名も記入）	無/不明 検討中 決定 2 4 6 8 10	無/不明 有 決定 1 2 3 ④ 5	製品名：（　）
②他社回避可能性（他社実施可能性、代替技術を考慮して評価）	容易 可能 困難 1 2 3 4 5	容易 可能 困難 1 2 3 ④ 5	
③技術の優位性（技術的、経済的効果を先行技術と比較して評価）	同等 高 飛躍的 1 2 3 4 5	同等 高 飛躍的 2 ③ 4 5	同等 高 基本的 1 2 3 4 5
④独創性（解決しようとする問題点、着想の独創性を評価）		平凡 斬新 2 ③ 4 5	平凡 斬新 1 2 3 4 5
⑤技術的実現性（将来の技術もふまえて評価）			不明 可能 強評済 1 2 3 4 5
⑥開発テーマとの関係（開発テーマに関連する発明については開発テーマ名を記入）	有・無 テーマ名：（　）	有・無 テーマ名：（　）	無 未定 有 1 2 3 4 5 テーマ名：
合計点		発明者：14点　評価担当：14点	

発明の総合評価	評価者コメント記入欄（評価項目に関する補足コメント）
1.Aランク（基本発明または事業戦略上必須な発明） 2.Bランク（自社または他社が実施する可能性大な発明） 3.Cランク（他社の権利化を阻止する防衛出願的な発明） 4.Dランク（出願見合わせ、公開不要）	将来技術として有望である。（山田）

日本出願の緊急度	審査請求の要否	外国出願の要否
1.通常（D部受付後4ヶ月以内に出願） ②急ぎ（D部受付後3ヶ月以内に出願）	1.する（1年以内） ②未定 3.しない	①定ひ出願（出願国：USA　） 2.できれば出願（出願国：　） 3.しない

D部記入欄

ランク	合計点	国内出願	外国出願	審査請求	D部コメント記入欄
B	14	①単独 2.併合 3.分割 4.国内優先	1.出願要 出願国：（USA） 2.出願不要	1.請求要 ②不明 3.請求不要	

発明報告書・譲渡書（A表）

整理番号
P010619

発明者	上長	評価担当	部門長	D受付	D長	事務所費用
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社内発明者

発明の名称	固体撮像装置
出願権の譲渡および同意	この発明に関し、日本および外国において特許を受ける権利を富士フイルムマイクロデバイス株式会社に譲渡いたします。 また、この発明に関し、共同発明者がその使用者等に自己の持分を譲渡することに同意いたします。

	発明者順序	社員番号	氏名	寄与率%	捺印
社内発明者	1	981118	鈴木信雄	50	鈴木
	2	713299	益金和弘	50	益金

発明者人数 社内	社外	合計	共願人（FF以外）	契約	※ 社内発明者が6名以上の場合は本用紙をもう一部追加用紙として使用する。
2	0	2	1.なし 2.あり（共願人名：　　）	1.あり 2.なし	

発明者（FFM以外）

出願人の数（含FFM）	社	出願手続会社		
会社名又は個人名	出願人要否	序列	郵便番号	住所
富士ﾌｲﾙﾑﾏｲｸﾛﾃﾞﾊﾞｲｽ	1.要 2.否		981-3408	宮城県黒川郡大和町松坂平1丁目6番地
1 富士写真フイルム	1.要 2.否			
2	1.要 2.否			

※出願人「否」の場合は序列以下について記入不要

代表者資格	代表者氏名	持分	費用負担	負担費用の対象
1 代表取締役社長	古森　重隆	%	%	1.全費用 2.出願時費用
2		%	%	1.全費用 2.出願時費用

社外発明者	会社名	発明者順序	氏名	寄与率	捺印

※発明者順序および寄与率は全発明者（社内、社外区別なし）を対象とする。

出願権の譲渡および同意	この発明に関し、日本および外国において特許を受ける権利を貴社（富士フイルムマイクロデバイス株式会社、　　）に譲渡いたします。また、この発明に関し、共同発明者がその使用者等に自己の持分を譲渡することに同意いたします。

開発部長殿　　発明開示書　　２００２年3月１１日

K　部　鈴木　信雄

（１）発明の名称

固体撮像装置

（２）発明の技術分野

固体撮像装置に関わるもので、特に広いダイナミックレンジをもつカラーＣＣＤイメージセンサに関するものである。

（３）従来技術とその欠点（他社特許、文献についてはコピー添付）

単板カラー固体撮像装置の従来例を図１に示す。図１は単板カラー固体撮像装置の構成図である。図１の従来例は、プログレッシブ走査型で、１度に２次元画素配列の信号電荷を垂直 CCD レジスタに転送し、読み出すことが出来るＣＣＤエリアイメージセンサである。画素数は数１０万から数１００万であるが、その部分は図１において省略している。２次元画素配列、３相駆動の垂直ＣＣＤレジスタ（３層ポリシリコン電極構造）、２相駆動の水平 CCD レジスタ、出力部から成っている。色フィルタ配列は、通常の画素配列を持つ単板カラー固体撮像装置に使用されている Bayer 方式の色フィルタ配列である。

（図１の補足説明）

１１：画素（フォトダイオード）　　１２：垂直ＣＣＤレジスタ
１３：画素から垂直ＣＣＤレジスタの転送電極に信号電荷を読み出すための読み出しゲートの位置
１４～１６：転送電極　　１７～１９：転送電極
３０：水平ＣＣＤレジスタ　　３１：出力部
３２：出力
３３、３４、４０～４２：電極端子　　１１ｇ：緑の色フィルタの画素
１１ｂ：青の色フィルタの画素　　１１ｒ：赤の色フィルタの画素

従来例を用いたデジタルスチルカメラの場合、室内から窓越しの外の景色が真っ白になってしまうことがある。これを避けるため、短時間間隔で連続撮影した２枚の画像（高感度と低感度）から広いダイナミックレンジの画像を合成することが行われる。

従来例の欠点：　合成する２枚の画像は時刻が同時でないため動いてる被写体を撮ると、不自然な画像となる。

発明と従来技術との相違　：　低感度画素と高感度画素を設けた固体撮像装置であり、さ

らに低感度画素（小さい画素）を水平と垂直方向共に高感度画素のピッチの１／２ずれた位置に設けた点が異なる。

（4）発明が解決しようとしている課題

動く被写体が自然に撮れる広いダイナミックレンジを持つ画像が得られる固体撮像装置を実現する。

（５）課題を解決するための手段

低感度画素と高感度画素を設けることにより高感度画像と低感度画像の同時性を確保し、しかも、小さい低感度画素を水平方向と垂直方向共に高感度画素のピッチの１／２ずらした位置に設けることにより、画質低下（感度と飽和出力の低下による）を回避して前記課題を解決する。

（６ａ）実施例

図２に固体撮像装置の第１の実施例を示す。図２（ａ）は全体構成図、図２（ｂ）と（ｃ）はマイクロレンズの説明図を示す。広いダイナミックレンジの画像を得るためには、低感度画素の感度は高感度画素のおよそ１／４から１／１２８程度に設定することが望ましい。その場合、低感度画素の飽和信号電荷量は、高感度画素の１～１／６４程度に設定することが望ましい。低感度画素は高感度画素が飽和した状態でも一定の光量（例えば、高感度画素の飽和光量の４～１６倍程度）まで飽和しないことが必要である。図２（ｂ）に示すマイクロレンズの平面図の面積が感度にほぼ比例する。したがって、例えば感度比１／１６とすれば、高感度画素の感度低下は６％程度であり、感度低下は殆どない。また、飽和電荷量はほぼフォトダイオードの面積に比例する。したがって、感度比１／１６で４倍飽和を選べば、低感度画素のフォトダイオード面積は高感度画素のフォトダイオード面積の１／４となる。この低感度画素のフォトダイオード面積増は小さくない。しかし、従来例の画素間の配線部分が占める割合が大きいのに対して本実施例では、低感度画素を高感度画素のピッチ値の中間に設けているため、この配線部が無くなっている。そのため、この面積減少を含めると、低感度画素を新たに設けたためのフォトダイオード面積増は極めて小さいものとなる。即ち、本実施例で、従来例に対し低感度画素配列が増えたにも関わらず、高感度画素の感度と飽和電荷量は殆ど低下せず、従来の性能が維持される。
なお、この実施例では、１回の水平ＣＣＤレジスタ読出しで、高感度画素１行と低感度画素１行が読み出される。

詳しい説明省略（口頭で説明します）。

（図２（ａ）の補足説明）

１１０：低感度画素（フォトダイオード）
１１１：高感度画素（フォトダイオード）
１１２：４相駆動の垂直ＣＣＤレジスタ（２層ポリシリコン電極構造）
１１３：画素から垂直ＣＣＤレジスタの転送電極に信号電荷を読み出すための読み出しゲートの位置
１１４～１１７：転送電極　　１１８，１１９：転送電極
１３０：水平ＣＣＤレジスタ　　１３１：出力部
１３２：出力
１３３、１３４、１４０～１４３：電極端子
１１０ｇ：緑の色フィルタの低感度画素　１１０ｂ：青の色フィルタの低感度画素
１１０ｒ：赤の色フィルタの低感度画素　１１１ｇ：緑の色フィルタの高感度画素
１１１ｂ：青の色フィルタの高感度画素　１１１ｒ：赤の色フィルタの高感度画素

（６ｂ）その他の実施例

図３に第２の実施例を示す。固体撮像装置の第１の実施例では、垂直ＣＣＤレジスタは４相駆動ＣＣＤで、高感度画素と低感度画素を同時に読出していたが、第２の実施例では、垂直ＣＣＤレジスタが８相駆動ＣＣＤとなり、高感度画素と低感度画素を２回に分けて読み出すものとなっている。高感度画素と低感度画素を２回に分けて読み出すため垂直ＣＣＤレジスタの占める面積を小さく出来る。したがって、画素の面積が増加し、飽和出力が増加するという利点がある。１回の水平ＣＣＤレジスタ読出しで、高感度画素２行、または低感度画素２行が読み出される。

説明省略（口頭で説明します）。

（図３の補足説明）
２１０：低感度画素（フォトダイオード）
２１１：高感度画素（フォトダイオード）
２１２：垂直ＣＣＤレジスタ
２１３：画素から垂直ＣＣＤレジスタの転送電極に信号電荷を読み出すための読み出しゲートの位置
２１４～２２１：転送電極　　２２２，２２３：転送電極
２３０：水平ＣＣＤレジスタ　　２３１：出力部
２３２：出力
２３３、２３４、２４０～２４７：電極端子
２１０ｇ：緑の色フィルタの低感度画素　２１０ｂ：青の色フィルタの低感度画素
２１０ｒ：赤の色フィルタの低感度画素　２１１ｇ：緑の色フィルタの高感度画素
２１１ｂ：青の色フィルタの高感度画素　２１１ｒ：赤の色フィルタの高感度画素

なお、図３の実施例で、垂直ＣＣＤレジスタの第１相と第２相、第３相と第４相、第５相と第６相、第７相と第８相の電極を合体させた４相駆動ＣＣＤとしても同様な効果が得られる。

図４は第３の実施例を示す。第１の実施例と比較して垂直ＣＣＤレジスタ数が１／２となっている。これも、第２の実施例と同様に、高感度画素と低感度画素を２回に分けて読み出すものとなっている。高感度画素と低感度画素を２回に分けて読み出すため垂直ＣＣＤレジスタの占める面積を小さく出来る。したがって、画素の面積が増加し、飽和出力が増加するという利点がある。１回の水平ＣＣＤレジスタに読出しで、高感度画素１行、または低感度画素１行が読み出される。

説明省略（口頭で説明します）。

（図４の補足説明）

３１０：低感度画素（フォトダイオード）
３１１：高感度画素（フォトダイオード）
３１２：垂直ＣＣＤレジスタ
３１３：画素から垂直ＣＣＤレジスタの転送電極に信号電荷を読み出すための読み出しゲートの位置
３１４～３１７：転送電極　　３１８，３１９：転送電極
３３０：水平ＣＣＤレジスタ　　３３１：出力部
３３２：出力
３３３、３３４、３４０～３４３：電極端子
３１０ｇ：緑の色フィルタの低感度画素　３１０ｂ：青の色フィルタの低感度画素
３１０ｒ：赤の色フィルタの低感度画素　３１１ｇ：緑の色フィルタの高感度画素
３１１ｂ：青の色フィルタの高感度画素　３１１ｒ：赤の色フィルタの高感度画素

図５は第４の実施例を示す。第１～第３の実施例が広いダイナミックレンジの合成画像を得ることが目的であったが、第４の実施例は、高解像度の画像を得ることが目的である。そのため低感度画素の色フィルタが白１色となっている。低感度画素の色フィルタ以外の構造は第１から第３の実施例と同じである。図５は色フィルタのみ示す。白は色フィルタが無い画素、または透明な色フィルタがある画素を意味する。
この白画素信号と高感度画素信号から局部的な画像の特徴（相関方向等）を検出して、高感度画素信号と白画素信号から輝度信号を生成することにより高解像度の画像が得られる。
なお、低感度の色フィルタは白に限らず、緑、黄色、シアン等でも良い。

なお、下記のように様々な形で実施できる。

１）原色ベイヤーの色フィルタ配列に限らず、シアン、緑、黄色、マゼンタの市松補色フ

ィルタ配列、ストライプフィルタなどでも良い。（図６は補色フィルタの例を示す。）

２）これまで、高感度画素と低感度画素を常に読み出すことを前提に説明したが、広いダイナミックレンジ画像や高解像度画像を必要としない場合には、高感度画素だけを読み出して、低感度画素の読出しは行わなくても良い。高感度画素の出力信号のみを信号処理して通常の画像が得られる。

３）マイクロレンズの形状は、図２（ｂ）のように平面図上で、高感度画素が８角形で、低感度画素が４角形であることに限定されず、４角形以上の多角形であれば良い。

４）マイクロレンズはそのままで、色フィルタをすべて無くした白黒の固体撮像装置（第１～第３の実施例）を使用して広いダイナミックレンジを持つ３板カラーカメラを作ることも可能である。

（７ａ）発明の効果

従来例に比較して高感度画像と低感度画像の同時刻性があり、動く被写体を撮っても自然な合成画像が得られる。さらに、小さい低感度画素を水平方向と垂直方向共に高感度画素のピッチの１／２ずらした位置に設けることにより、感度と飽和出力の低下による画質低下が殆どない。

また、低感度画素を白フィルタ（実際は色フィルタ無し）として、信号処理を行うことで高解像度の画像が得られる。

（８ａ）特許請求の範囲

１）行方向とこれに直交する列方向に正方格子状に配列された高感度画素配列と、行方向方と列方向に高感度画素配列のピッチの１／２ずれた位置に配列された低感度画素配列から成る受光部と、
受光部の各画素に光発生した信号電荷を読出し、列方向に転送する垂直ＣＣＤレジスタ群と、
垂直ＣＣＤレジスタ群から転送された信号電荷を受け取り、行方向に信号電荷を転送する水平ＣＣＤレジスタと、
水平ＣＣＤレジスタから転送された信号電荷を出力する出力部とから成る固体撮像装置。

２）前記垂直ＣＣＤレジスタ群は前記受光部の全信号電荷を同時に読み出すことが出来ることを特徴とする第１項記載の固体撮像装置。

３）前記垂直ＣＣＤレジスタ群は前記受光部の高感度画素と低感度画素の信号電荷を２回

に分けて読み出すことが出来ることを特徴とする第１項記載の固体撮像装置。

４）高感度画素配列と低感度画素配列の奇数行が赤と緑、または緑と青の色フィルタが交互に配列され、高感度画素配列と低感度画素配列の偶数行が緑と青、または赤と緑の色フィルタが交互に配列されたことを特徴とする第１～第３項の固体撮像装置。

５）高感度画素配列と低感度画素配列の奇数行がマゼンタと緑、またはシアンと黄色の色フィルタが交互に配列され、高感度画素配列と低感度画素配列の偶数行がシアンと黄色、またはマゼンタと緑の色フィルタが交互に配列されたことを特徴とする第１～第３項の固体撮像装置。

６）高感度画素配列の奇数行が赤と緑、または緑と青の色フィルタが交互に配列され、高感度画素配列の偶数行が緑と青、または赤と緑の色フィルタが交互に配列され、低感度画素配列に白（色フィルタ無し）、または緑、または黄色、またはシアンの色フィルタを設けたことを特徴とする第１～第３項の固体撮像装置。

７）高感度画素配列の奇数行がマゼンタと緑、またはシアンと黄色の色フィルタが交互に配列され、高感度画素配列の偶数行がシアンと黄色、またはマゼンタと緑の色フィルタが交互に配列され、低感度画素配列に白（色フィルタ無し）、または緑、または黄色、またはシアンの色フィルタを設けたことを特徴とする第１～第３項の固体撮像装置。

（９）図面の簡単な説明

本文中にあり、省略。

－　以上　－

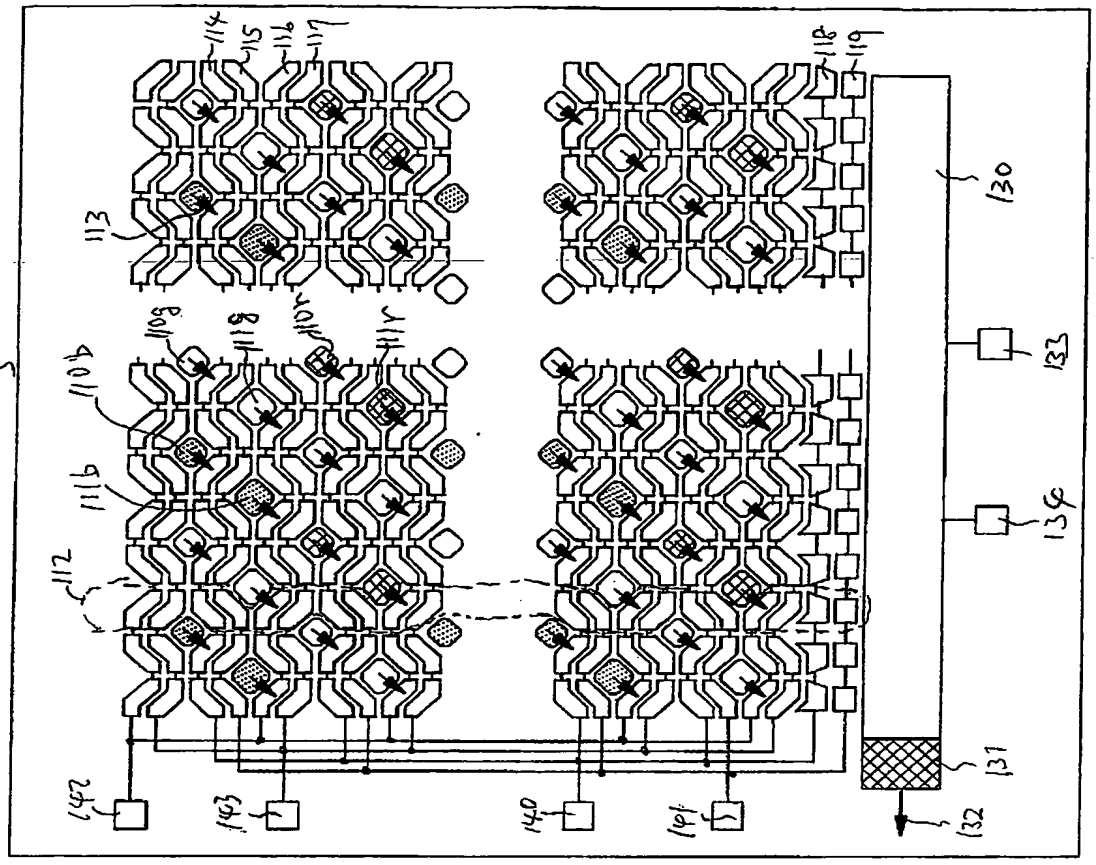


Fig. 2(a)

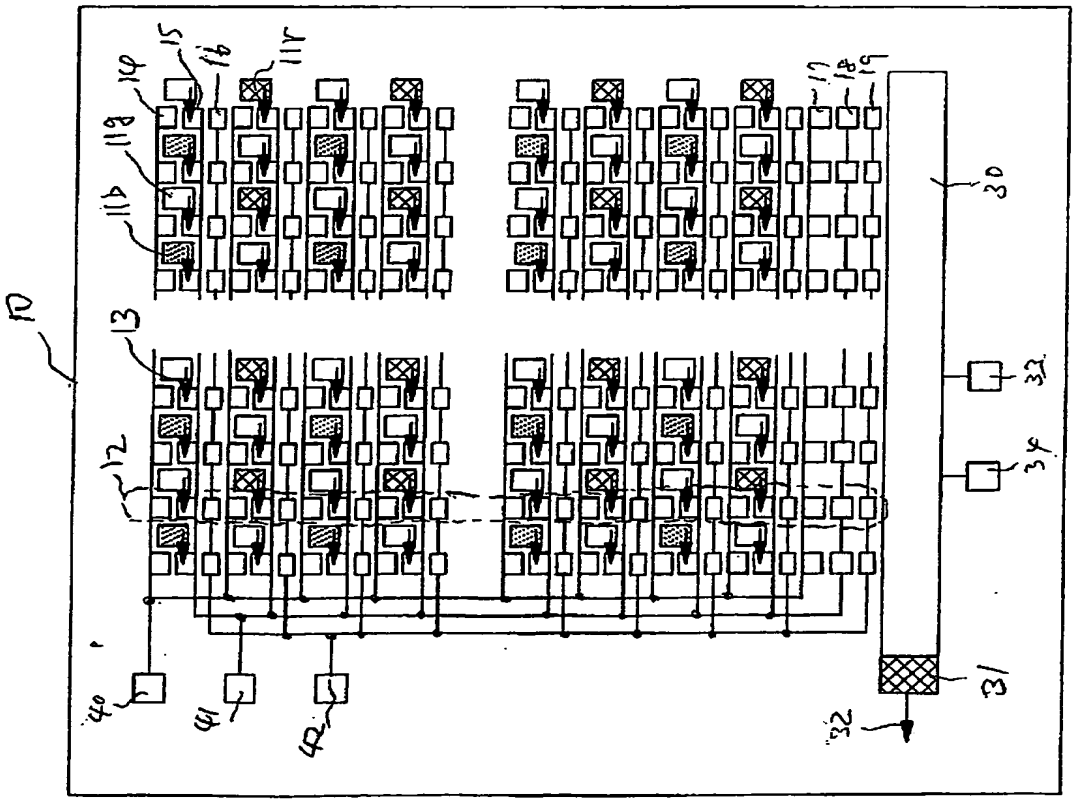


Fig. 1

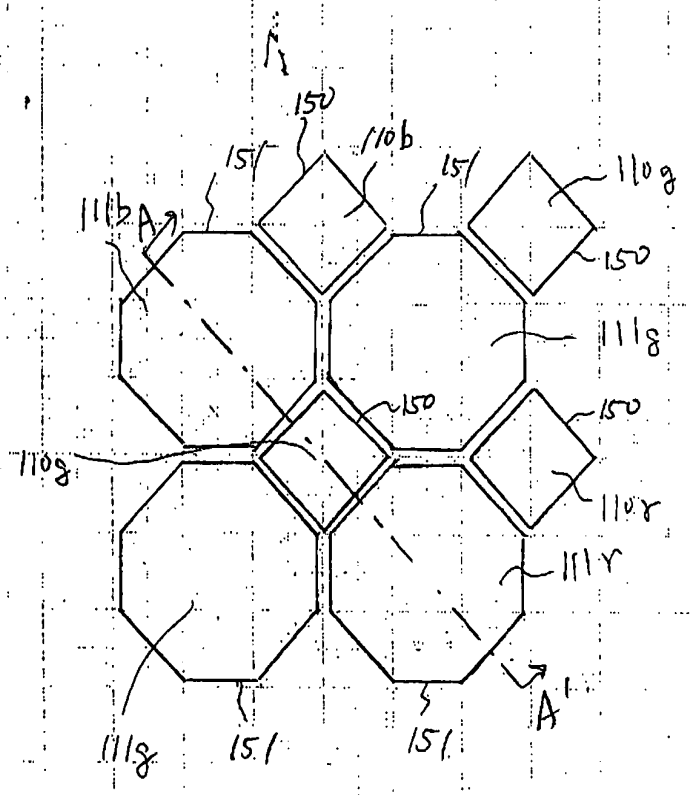
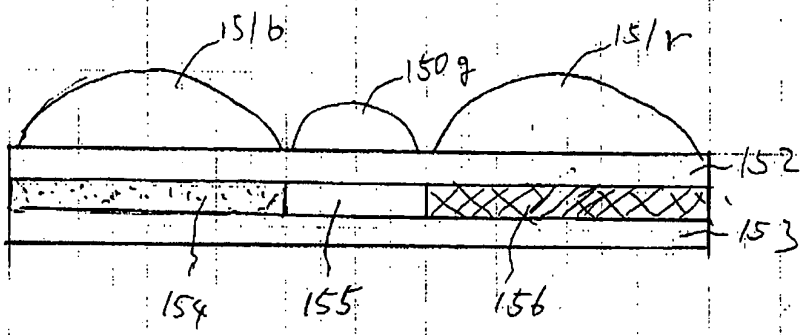


図2(b)



151…高屈折率のマイクロレンズ
150…低屈折率のマイクロレンズ
152, 153…透明層

図2(c)

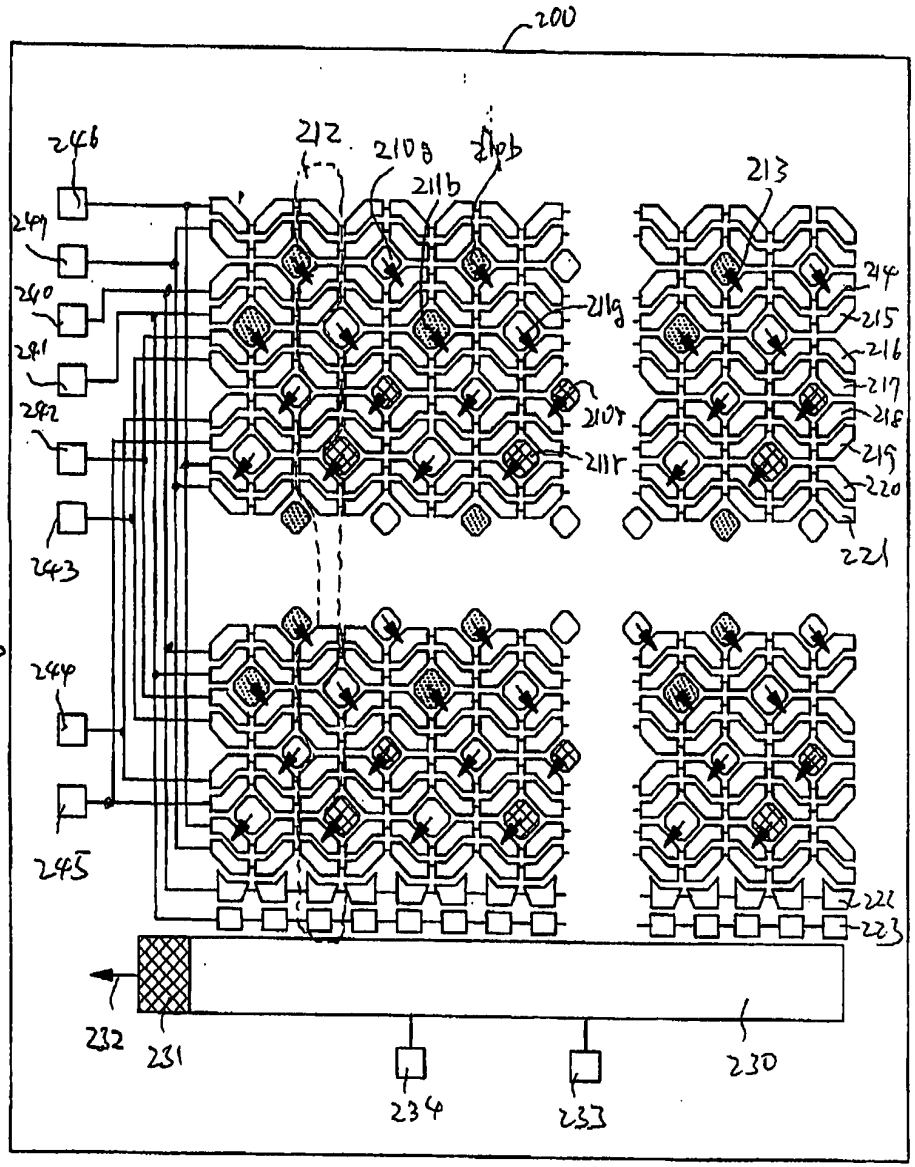

200
246
212
210a
210b
211b
213
249
214
260
211g
215
216
261
217
210r
262
218
211r
219
220
263
221
264
222
223
265
232
231
234
233
230

图3

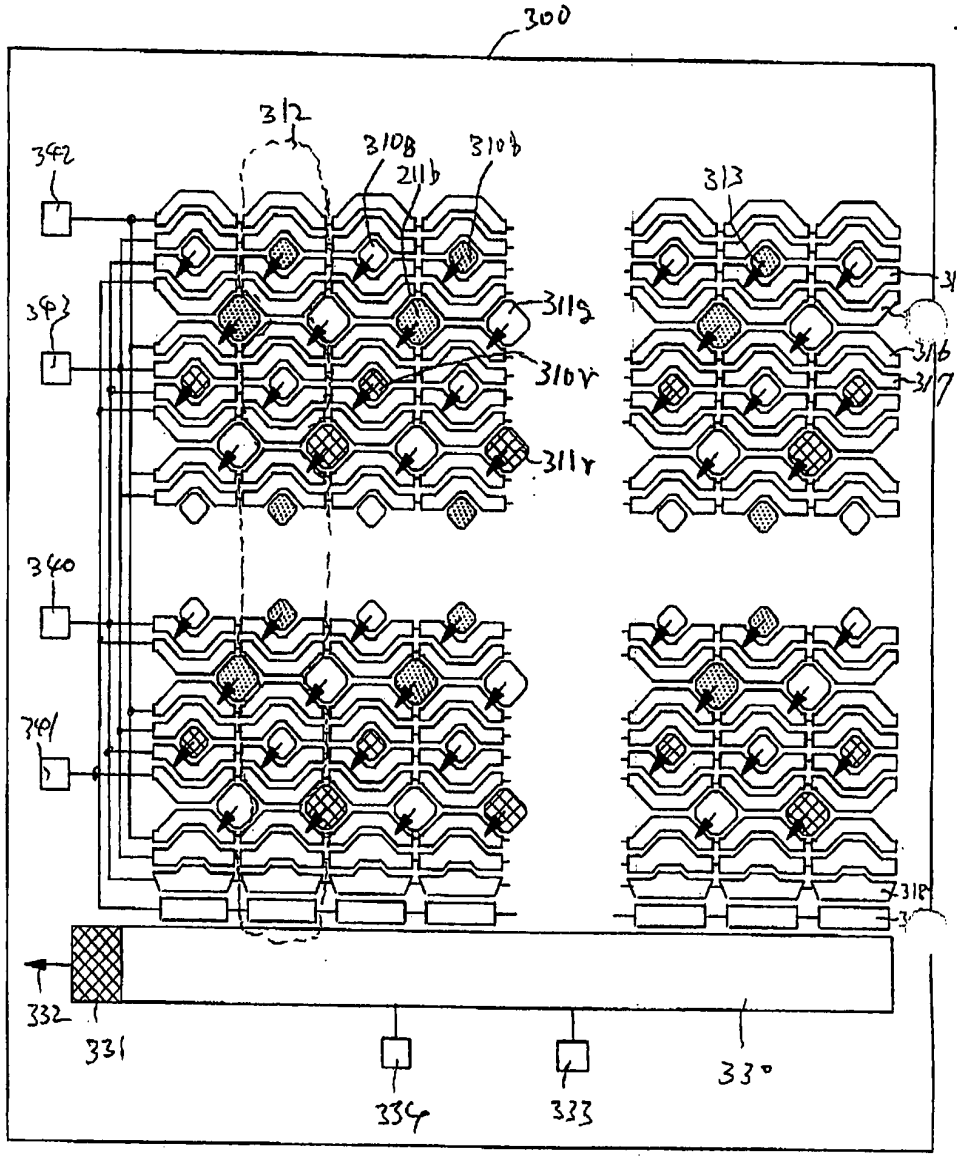

300
312
342
310a
310b
211b
313
314
343
311g
316
310r
317
311r
340
341
318
332
331
334
333
330

图4

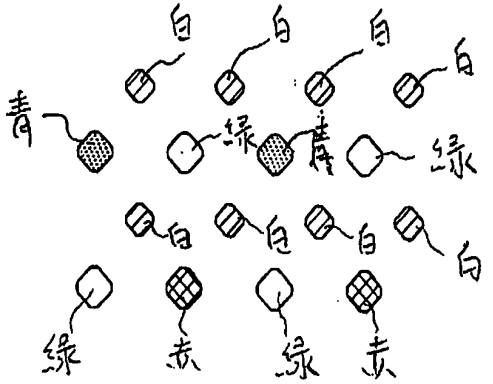

白
白
白
白
青
緑
青
緑
白
白
白
白
緑
赤
緑
赤

図5

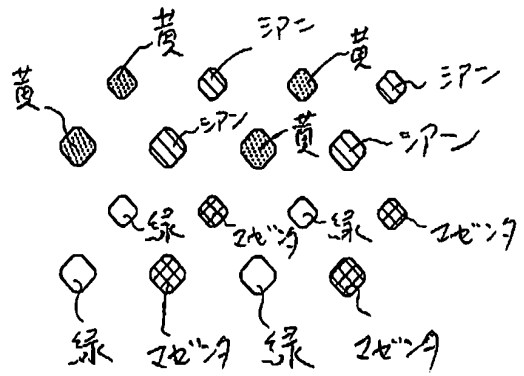

黄
シアン
黄
シアン
黄
シアン
黄
シアン
緑
マゼンタ
緑
マゼンタ
緑
マゼンタ
緑
マゼンタ

図6